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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 10/562,618
Filing Date: May 15, 2006
Appellant(s): BOER ET AL.

Kevin M. Mason
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed April 5, 2011 appealing from the Office action mailed November 26, 2010.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

No amendment after Final has been filed.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

- Admitted Prior Art (Applicant's Background Disclosure in the Specification, Particularly Figures 1-3 and Page 1, line 20 to page 5, line 19 of the applicant's Specification).
- Shattil U.S. Pub. No. 2004/0141548 A1 December 8, 2003
- Joo U.S. Pub. No. 2004/0208253 A1 August 27, 2002
- P.W. Wolniansky "V-Blast: An Architecture for Realizing Very High Data Rates Over the Rich-Scattering Wireless Channel" (document provided by applicant in the background section of the specification. see Applicant's specification page 2, lines 9-10).
- IEEE Std 802.11a-1999 "Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specification" (document provided by applicant in the background section of the specification. see Applicant's specification page 1, lines 22-23).

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(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1-7, 11-16 and 21-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's Background Disclosure in the Specification, particularly Figures 1-3 and page

4, line 18 through page 5, line 19 (herein Admitted Art) in view of Shattil (US 2004/0141548 A1).

Referring to claim 1, Admitted Art discloses a method for transmitting one or more symbols in a multiple antenna wireless communication system (Fig. 1-3 and Page 5, lines 5-10, "MIMO-OFDM"), said method comprising the step of:

loading subcarriers from said one or more symbols across a plurality of antennas in said multiple antenna wireless communication system (Figures 1-3 and page. 5, lines 5-16, note that subcarriers are interleaved in OFDM subcarriers).

Admitted Art does not specifically disclose that the symbols are loaded diagonally.

In an Analogous art, Shattil discloses that symbols are loaded into subcarriers diagonally (Fig. 9A and Par. 0163).

It would have been obvious to a person of ordinary skill in the art at the time of invention to modify the Admitted Art such that symbols are loaded diagonally into the subcarriers, for the purpose of minimizing interference and thus providing improving the quality of transmitted signal.

Referring to claim 2, the combination of Admitted Art and Shattil discloses the method of claim 1, and further discloses said one or more symbols are long training symbols based on a single-antenna long training symbol and wherein each subsequent subcarrier from said single-antenna long training symbol is positioned in a long training symbol for a logically adjacent antenna (Admitted Art, Fig. 3, and page 5, lines 5-10, "long training symbols", note that in

OFDM long training symbols are inherently based on a single antenna. Further, the diagonal loading of symbols in Shattil implies that each subsequent subcarrier from said single-antenna long training symbol is positioned in a long training symbol for a logically adjacent antenna)

Referring to claim 3, the combination of Admitted Art and Shattil disclose the method of claim 2, wherein said single-antenna long training symbol is an 802.11 a/g long training symbol (Admitted Art, Page 5, lines 5-6, "IEEE 802.11 a/g").

Referring to claim 4, the combination of Admitted Art and Shattil disclose the method of claim 1, wherein said one or more symbols are short training symbols based on a single-antenna short training symbol and wherein each subsequent subcarrier from said single-antenna short training symbol is positioned in a short training symbol for a logically adjacent antenna (Admitted Art, Fig. 3, and page 5, lines 5-10, "short training symbols").

Referring to claim 5, the combination of Admitted Art and Shattil disclose the method of claim 4, wherein said single-antenna short training symbol is an 802.11 a/g short training symbol (Admitted Art, Fig. 3, and page 5, lines 5-10).

Referring to claim 6, the combination of Admitted Art and Shattil discloses the method of claim 1, wherein said multiple antenna wireless communication system is a MIMO-OFDM system (Admitted Art, Fig. 1-3 and page. 5,lines 2-3).

Referring to claim 7, the combination of Admitted Art and Shattil discloses the method of claim 1, further comprising the step of inserting one or more additional subcarriers in at least

one of said plurality of symbols (Admitted Art, page 4, line 20 through page 5,line 10, note that inserting additional subcarriers is inherent in OFDM).

Referring to claim 11, the combination of Admitted Art and Shattil disclose the method of claim 1, wherein said one or more symbols are a SIGNAL-field symbol (Admitted ART,page 5, lines 10-19, note that preamble and data fields are inherent in OFDM channel estimation).

Referring to claim 12, the combination of Admitted Art and Shattil discloses the method of claim 11, wherein said SIGNAL-field symbol includes a system type indicator (page. 4 and , note that the preamble has system type information).

Referring to claim 13, the combination of Admitted Art and Shattil discloses the method of claim 2, wherein a number of said long training symbols is a function of the number of transmitters (Page. 4 and Fig. 1-3).

Referring to claim 14, the combination of Admitted Art and Shattil discloses the method of claim 1, further comprising the steps of diagonally loading a remainder of a header of a packet across said logically adjacent antennas; and diagonally loading data sequences of said packet across said logically adjacent antennas (Fig. 1-3, and pages 4, line 20- page 5, line 18).

Referring to claim 15, the combination of Admitted Art/Shattil discloses the method of claim 1, wherein said plurality of antennas are logically adjacent (page 5,line 2, note that in MIMO antennas are logically adjacent).

Referring to claim 16, the combo of Admitted Art and Shattil discloses the method of claim 1, whereby a lower order receiver can interpret said transmitted diagonally loaded symbols as a normal OFDM frame (Page . 4 and page 5 lines 1-5, note both lower order and upper order receivers can interpret and diagonally transmitted signal).

Claim 21-25 are analogous to the features of claim 1, 2, 6, 11 and 14, thus they are rejected for the same reason used in the rejection of claims 1, 2, 6, 11 and 14.

3. Claims 8, 17, 18 and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's Background, particularly Figures 1-3 and page 4, line 18 through page 5, line 19 (herein Admitted Art) in view of Shattil (US 2004/0141548 A1) and further in view of Joo (US 2004/0208253 A1).

Referring to claim 8, the combination of Admitted Art and Shattil disclose the method of claim 7.

The above combination does not specifically disclose where said one or more additional subcarriers are inserted to ensure that any subcarrier that was nulled by said diagonal loading is surrounded by subcarriers that are not nulled.

Joo discloses nulling subcarriers that are not diagonally loaded and inserting non-nulled subcarriers adjacent to nulled subcarriers (abstract and Par. 25).

It would have been obvious to a person of ordinary skill in the art at the time of invention to modify the method of Li in the format disclosed for the purpose of providing an efficient communication system.

Referring to claim 17, Admitted Art discloses a method for generating a plurality of long training symbols in a in a multiple antenna wireless communication system (Page 4-5 and Fig. 1-3), said method comprising the step of:

loading subcarriers from a single-antenna long training symbol across long training symbols associated with logically adjacent antennas in said multiple antenna wireless

communication system (Page. 4-5, note that loading subcarriers is inherent in OFDM. Further note that there is at least one transmitter and one receiver, thus a multiple antenna system);

Admitted Art does not specifically disclose that the symbols are loaded diagonally.

In an Analogous art, Shattil discloses that symbols are loaded into subcarriers diagonally (Fig. 9A and Par. 0163).

It would have been obvious to a person of ordinary skill in the art at the time of invention to modify the Admitted Art such that symbols are loaded diagonally into the subcarriers, for the purpose of minimizing interference and thus providing improving the quality of transmitted signal.

The above combo does not specifically disclose nulling subcarriers in said plurality of long training symbols that are not diagonally loaded; and inserting at least one additional subcarrier to ensure that a nulled subcarrier has at least one subcarrier located on each side of said nulled subcarrier.

Joo discloses nulling subcarriers that are not diagonally loaded and inserting non-nulled subcarriers adjacent to nulled subcarriers (abstract and Par. 25).

It would have been obvious to a person of ordinary skill in the art at the time of invention to modify the combination in the format disclosed for the purpose of providing an efficient communication system.

Referring to claim 18, the combo of Admitted Art, Shattil and Joo discloses the method of claim 17, wherein said single-antenna long training symbol is an 802.11 a/g long training symbol (Admitted Art page 5, lines 5-19).

Referring to claim 20, the combo of Admitted Art, Shattil and Joo discloses the method of claim 17 and further disclose wherein a reduced number of subcarriers are inserted in at least one of said plurality of long training symbols and wherein a first long training symbol and a second long training symbol are interchanged to position at least one non-nulled subcarrier on at least one side of a nulled subcarrier (Joo, Par. 25).

It would have been obvious to a person of ordinary skill in the art at the time of invention to modify the method of Li in the format disclosed for the purpose of providing an efficient communication system.

Claims 26 and 27 are rejected for the same reason as claims 1 and 17.

Claim 28 is rejected for the same reason as claim 14.

Claims 29-30 are rejected for the same reasons as claims 17 and 14.

Claims 31-32 are rejected for the same reasons as claims 17 and 14.

Claims 33-34 are rejected for the same reasons as claims 17 and 14.

4. Claims 9 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's Background Disclosure in the Specification, particularly Figures 1-3 and page 4, line 18 through page 5, line 19 (herein Admitted Art) in view of Shattil (US 2004/0141548 A1) and further in view of well-known prior art (MPEP 2144.03).

Referring to claim 19, the combo of Admitted Art, Shattil and Joo discloses the method of claim 17.

The combination does not specifically disclose where said at least one additional subcarrier allows nulled subcarriers to be estimated using an interpolation-based channel estimation technique.

Examiner takes official notice of the fact using an interpolation-based channel estimation is well known in the art.

It would have been obvious to a person of ordinary skill in the art at the time of invention to modify the above combination by using the well-known interpolation technique for the purpose of providing an efficient communication system.

Claim 9 is rejected for the same reasons that claim 19 is rejected.

Allowable Subject Matter

5. Claim 10 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is the examiner's statement of reasons for allowance:

The prior art fails to teach or suggest the limitation, "a reduced number of subcarriers are inserted in said at least one of plurality of long training symbols and wherein a first long training symbol and a second long training symbols are interchanged to position at least one non-nulled subcarrier on at least one side of a nulled subcarrier," along with other limitations of the intervening claims 1 and 2.

(10) ***Response to Arguments***

Rejection of Independent Claims 1, 17, 21, 26, 29, and 31-34.

Arguments with respect to claims 1 and 21

In response to applicant's arguments that "neither the rows nor the columns of FIG. 9A represent *different antennas.* Shattil does *not* disclose or suggest *diagonally loading subcarriers from one or more symbols* and does *not* disclose or suggest *diagonally loading across a plurality of antennas* in a multiple antenna wireless communication system. Independent claims 1 and 21 require *diagonally loading subcarriers from said one or more symbols across a plurality of antennas* in said multiple antenna wireless communication system," the examiner respectfully disagrees.

The examiner asserts that based on the broadest reasonable interpretation of the claimed limitations consistent with the specification, the claimed limitation "multiple antenna wireless communication system" is equivalent to any wireless communication system that has one antenna at the transmit side and one antenna at the receive side. Further, Admitted Art teaches a MIMO-OFDM system that includes multiple antennas at the receiver side and multiple antennas at the transmitter side (see Admitted Art figure 1 and Admitted Art specification page 4, line 28 through page 5, line 4, "transmitters TX_1 to TX_{Nt}," "receivers RX_1 to RX_{Nr}", note figure 1 discloses that there are N_t antennas at the transmitter side and N_r antennas at the receiver side. Also see Shattil, figures 1A, 1B, par. 21, 22, 51, 52 and 53. "In FIG. 1A, a transmitter is

provided with a weight vector", "A receiver employs a complex conjugate of the appropriate communication waveform, as shown in FIG. 1B", "cellular communications standards (such as GSM, IS-95, and UMTS)", Note that Shattil' s figure 1A describes a transmitter and figure 1B describes a receiver for a cellular communication system that intrinsically is a multiple antenna communication system because there is at least one antenna at the transmitter and one antenna at the receiver.

Thus, both the Admitted Art and Shattil meet the above limitation (see Shattil, Figures 9A-9B and Paragraph 163, and Admitted Art Figures 1-3). Further, the limitation "diagonally loading subcarriers from said one or more symbols across a plurality of antennas" is equivalent to diagonally loading symbols (e.g., w_1) in the system of Shattil. Shattil' s diagonal loading of symbols (e.g., w_1, w_1) across multiple antennas (e.g., one at the receive side and one at the transmit side) read on the claimed limitation based on a broad interpretation since neither the specification nor the claim language indicate how diagonal loading is performed. The specification does not describe details of diagonal loading across multiple antennas.

Arguments with respect to claim 17

Claim 17 basically encompasses the limitation of diagonal loading as described in claim. However, claim 17 further includes additional limitation of "long training symbols" instead of symbols of claim 1. Further, claim 17 includes the additional limitation of nulling any subcarriers that are not diagonally loaded and inserting an additional subcarrier to ensure that a nulled subcarrier has at least one subcarrier located on each side of the nulled subcarrier.

The examiner asserts that based on a broad interpretation of the claimed limitations, the combination of Admitted Art and Shattil teach all of the limitations of claim 17.

First, with respect to the symbols being "long training symbols," the examiner asserts that Shattil teaches diagonal loading of symbols as explained in the rejection of claim 1. Shattil does not disclose that the symbols are long training symbols. However, Admitted Art clearly teaches that the transmitting of long training symbols is conventional in IEEE 802.11a/g (see Admitted Art, page 5, lines 5-16), and it would have been obvious to transmit such long training symbols in the claimed diagonal format so that the transmitting of such training symbols do not interfere with each other.

With regards to the nulling of subcarriers that are not diagonally loaded, the examiner asserts that figure 9B of Shattil shows that all the remaining subcarrier that are not diagonally loaded are empty (nulled), thus it reads on the claimed language. Further, the examiner asserts that the claimed limitation, "diagonal loading," inherently implies that the non-diagonally loaded subcarriers are nulled. Further, figure 9B shows that a nulled subcarrier has at least one subcarrier located on each side of the nulled subcarrier

Arguments with respect to claims 26 and 29

The examiner asserts that based on a broad interpretation of the claimed limitations, the combination of Admitted Art and Shattil teach all of the limitations of claims 26 and 29.

The examiner asserts that the limitation "each of said subcarriers are active on only one of said plurality of antennas at a given time," is disclosed in Shattil. Shattil, in figure 9B

discloses a large bandwidth (carrier) divided into plurality of subcarriers where each subcarrier has its own time units, e.g., t_1, t_2, t_3 and t_4. Further, the examiner asserts that each subcarrier inherently can only be used either as receive subcarrier or transmit subcarrier because each time based portion of the frequency (also referred to as slot) can communicate only in one direction at the assigned given time period. Thus, each subcarrier is active either with transmit antenna or receive antenna at the given time. Thus, based on a broad interpretation of the claims, Shattil' s disclosure read on the claimed limitations.

With respect to claims 31-34, the examiner asserts that the Shattil disclose the limitations of diagonal loading across the plurality of antennas as described above in the rejection of claims 1 and 17.

With regards to dependent claims 2 and 22, the examiner asserts that based on a broad interpretation of the claimed limitations, the combination of Admitted Art and Shattil teach all of the limitations of claims 2 and 22 for the following reasons:

First, with respect to the symbols being "long training symbols," the examiner asserts that Shattil teaches diagonal loading of symbols as explained in the rejection of claim 1. Shattil does not disclose that the symbols are long training symbols. However, Admitted Art clearly teaches that the transmitting of long training symbols is conventional in IEEE 802.11a/g (see Admitted Art, page 5, lines 5-16), and it would have been obvious to transmit such long training symbols in the claimed diagonal format so that the transmitting of such training symbols do not interfere with each other.

Further, with regards to the limitation, "each subsequent subcarrier from said single-antenna long training symbol is positioned in a long training symbol for a logically adjacent antenna," the examiner asserts that Admitted Art teaches a MIMO system where multiple transmit antennas are at the transmit side and multiple receive antennas are in receiving side. Further, an artesian would recognize that the Admitted Art MIMO system inherently would include a MIMO channel matrix where the channel matrix can be diagonalized by using SVD decomposition. An artesian would recognize that the SVD decomposition would change the channel matrix into a diagonal channel where only subcarrier on the diagonal are used (loaded) for communication, and further each one of these diagonal subcarriers of the MIMO channel are used only by one transmit antenna on the transmitting side and one receive antenna on the receiving side. Thus, according such understanding of MIMO SVD channel, each subsequent subcarrier from a single-antenna long training symbol would be positioned in a long training symbol for a logically adjacent antenna.

With regards to dependent claim 4, the examiner asserts that Admitted Art teaches the transmitting of "short training symbols," (see Admitted Art, page 5, lines 5-16), and Shattil teaches diagonal loading of symbols as explained in the rejection of claim 1. It would have been obvious to transmit such long training symbols in the claimed diagonal format so that the transmitting of such training symbols do not interfere with each other.

Further, with regards to the limitation, "wherein each subsequent subcarrier from said single-antenna short training symbol is positioned in a short training symbol for a logically adjacent antenna," the examiner asserts that an artesian would recognize that the Admitted Art

MIMO system inherently would include a MIMO channel matrix where the channel matrix can be diagonalized by using SVD decomposition. An artesian would further recognize that the SVD decomposition would change the channel matrix into a diagonal channel where only subcarrier on the diagonal are used (loaded) for communication, and further each one of these diagonal subcarriers of the MIMO channel are used only by one transmit antenna on the transmitting side and one receive antenna on the receiving side. Thus, according such understanding of MIMO SVD channel, each subsequent subcarrier from a single-antenna short training symbol would be positioned in a short training symbol for a logically adjacent antenna. The examiner asserts that the specification does not include any explanation of how this is being done, thus, based on a broad interpretation of the claims, the Admitted Art MIMO SVD and the disclosure of Shattil read on the claimed language.

With regards to dependent claim 7, based on a broad interpretation of the claim, the combination of Admitted Art and Shattil disclose the claimed limitation, "inserting one or more additional subcarriers in at least one of said plurality of symbols." The examiner asserts that Admitted Art discloses a MIMO-OFDM system in figure 1 and page 4, lines 18-31. The examiner further asserts that an artesian would recognize a MIMO-OFDM channel is structures such that each MIMO subcarrier is turned into an OFDM carrier where the OFDM carrier is divided further into multiple smaller subcarriers. Thus, an artesian would recognize that the Admitted Art's MIMO-OFDM system can be modified such that additional OFDM subcarriers are inserted in at least one of said plurality of symbols. The specification does not provide any description for this limitation.

With regards to dependent claim 8, the examiner asserts that based on a broad interpretation of the claim, an artesian would be able to modify the cited references and come up with claimed limitation since Shattil discloses that the subcarriers that are not in the diagonal are nulled, and that it would increase orthogonally to put nulled subcarriers next to non-nulled ones.

With regards to dependent claim 20, the examiner asserts that based on a broad interpretation of the claim, an artesian would be able to modify the cited references and come up with claimed limitation since Admitted teaches the transmitting and using of long and short training symbols, and the examiner asserts that sending subsequent training symbols at different times would be inherent so the channel characteristics are known at different times, thus, exchanging of long training symbols as claimed is interpreted only as transmitting of long training symbols at different time periods.

With regards to dependent claims 14 and 25, the examiner assert that the combination of Admitted Art and Shattil discloses method and the transmitter of claims 1 and 21 respectively where symbols are transmitted diagonally (as rejected above). Admitted Art further discloses that the transmission of symbols takes place in a MIMO-OFDM system. Admitted Art further refers to two separate publications for the purpose of disclosing conventional and inherent features, standards, modulation and implementations of MIMO-OFDM system (see Admitted Art Page 1, line 21 through page 2, line 12, "OFDM modulation comply with the IEEE 802.11a/g," "IEEE Std 802.11a-1999," "For a detailed discussion of MIMO-OFDM decoding technique, see ... P.W. Wolniansky et al., 'V-Blast: An Architecture for Realizing Very High Data Rates Over the Rich-Scattering Wireless Channel,' 1998").

The V-Blast document by Wolniansky teaches that a symbol is broken down into four portions (packets) e.g., a_1, a_2, a_3 and a_4, and then each packet is transmitted by one of the four transmit antennas (see Figure 1 and the column under "System Overview.") In wireless communication systems a packet or portion of data (e.g., a from figure 1) must have a destination address in order to be routed to that destination address, and the destination address is placed in the header of the packet (see IEEE Std 802.11a-1999, page 6-7 and figure 107 at page 7). Thus, based on the above disclosures of Admitted Art including the documents incorporated therein by reference, the Admitted Art's diagonal loading of symbols can also be the diagonal loading of packets including the headers of the packets. Further, the claimed "logically adjacent antennas" are interpreted as two MIMO transmit antennas next to each other as disclosed in Admitted Art Figure 1, e.g., TX_1 and TX_2 are interpreted as adjacent antennas. Further, the V-Blast document by Wolniansky teaches data sequences (e.g., a_1, a_2, a_3 and a_4) of a packet (e.g., a) is loaded (e.g., to be transmitted) diagonally (see Wolniansky, the column under Introduction, particularly, lines 9-13, "D-Blast utilizes multi-element antenna arrays at both transmitter and receiver and an elegant diagonally-layered coding structure in which code blocks are dispersed across diagonals in space-time").

Thus, based on a broad interpretation of the claims and the cited references, an artesian would be able to recognize that the diagonal loading of symbols include the diagonal loading of the packets and their corresponding headers in the digital MIMO-OFDM communication system, as claimed, such that the packets are loaded (e.g., dispersed) across multiple MIMO antennas.

Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interference section of this examiner's answers.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

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/Patrick N. Edouard/

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/Charles N. Appiah/

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